Precise wavelengths and energy levels for the spectra of Cr I, Mn I, and Mn III, and branching fractions for the spectra of Fe II and Cr II

Completed Technology Project (2017 - 2020)

Project Introduction

I propose to measure wavelengths and energy levels for the spectra of Cr I, Mn I, and Mn III covering the wavelength range 80 nm to 5500 nm, and oscillator strengths for Fe II and Cr II in the region 120 nm to 2500 nm. I shall also produce intensity calibrated atlases and linelists of the iron-neon and chromium-neon hollow cathode lamps that can be compared with astrophysical spectra. The spectra will be obtained from archival data from spectrometers at NIST and Kitt Peak National Observatory and additional experimental observations as necessary from Fourier transform (FT) and grating spectrometers at NIST. The wavelength uncertainty of the strong lines will be better than 1 part in 10^7. The radiometric calibration of the spectra will be improved in order to reduce the uncertainty of measured oscillator strengths in the near UV region and extend the wavelength range of these measurements down to 120 nm. These will complement and support the measurements of lifetimes and branching fractions by J. E. Lawler in the near UV region. An intensive effort by NIST and Imperial College London that was partly funded by previous NASA awards has resulted in comprehensive analyses of the spectra of Fe II, Cr II and Cu II, with similar analyses of Mn II, Ni II, and Sc II underway. The species included in this proposal will complete the analysis of the first two ionization stages of the elements titanium through nickel using the same techniques, and add the spectrum of Mn III - one of the most important doubly-ionized elements. The elements Cr I and Mn I give large numbers of spectral lines in spectra of cool stars and important absorption lines in the interstellar medium. The spectrum of Mn III is important in chemically peculiar stars and can often only be studied in the UV region. Analyses of many stellar spectra depend on comprehensive analyses of iron-group elements and are hampered by incomplete spectroscopic data. As a result of many decades of work by the group at the University of Wisconsin-Madison (UW) accurate lifetimes exist for many of the most important levels of the iron-group elements needed for the interpretation of astrophysical spectra. The accuracy of the oscillator strengths is now limited by the accuracy of the branching fractions, particularly when the branches from an upper level span a wide wavelength range that requires multiple calibration lamps. A laser-driven light source as a calibration lamp will reduce the calibration uncertainty in the UV region. Our FT and grating spectrometers will be used to extend the wavelength region of the measurements from 120 nm to 2500 nm. Fe II and Cr II give thousands of lines in the UV stellar spectra but accurate oscillator strengths are available only for a few hundred in each species. Many lines remain unidentified in the laboratory spectra of Fe/Ne and Cr/Ne hollow cathode lamps that correspond to lines in stellar spectra. The proposed atlases and linelists of these lamps will assist astronomers in confirming the species of these spectra lines and help them to identify lines of other elements in stellar spectra that are not blended with iron or chromium lines. These measurements will be of importance in interpreting spectra obtained from many current and future NASA missions including the Hubble Space Telescope, the James Webb Space Telescope and SOFIA. They will be particularly

Image Not Available

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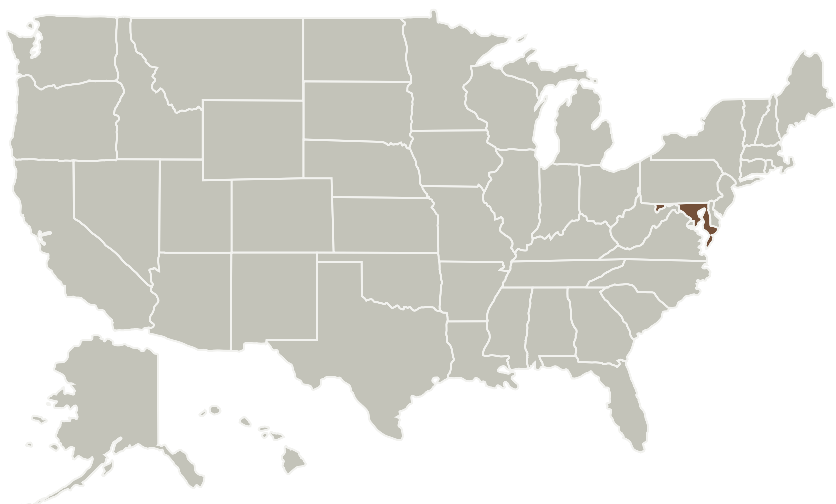
important in the analysis of spectra from the ASTRAL project - a large HST Treasury program that recorded the spectra of 29 bright and characteristic stars at high resolution and high signal-to-noise ratio. They will also be important for the interpretation of spectra from ground-based optical and infrared spectrographs. The proposed work thus supports the NASA Objective to explore the universe to understand its origin, structure, evolution and destiny.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
National Institute of Standards and Technology(NIST)	Lead Organization	US Government	Boulder, Colorado

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

National Institute of Standards and Technology (NIST)

Responsible Program:

Astrophysics Research and Analysis

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Gillian Nave

Co-Investigator:

Julie Weiblinger

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.5 Structural Dynamics
    └ TX12.5.2 Vibroacoustics

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Target Destination

Outside the Solar System